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(54) **CERAMIC CUTTING TOOL**

(57)Abstract:
PURPOSE: To provide a ceramic cutting tool which is essentially composed of alumina ceramic sintered body and can cut high hardness material efficiently and with a long life.
CONSTITUTION: Base material is alumina ceramic sintered body which contains at least one kind of titanum carbide, nitride, carbo-nitride or carbo-nitro-oxide of 10-50 weight percent in the matrix of $Al_2O_3$. A ceramic cutting tool is composed of this base material and either (1) at least, one of the carbide, the nitride or the carbo-nitride of the alloy of Ti and Al provided on the surface of this base material, or (2) combination of, at least, one of the carbide, the nitride or the carbo-nitride of the alloy of Ti and Al provided on the base material and, at least, one of the carbide, the nitride or the carbo-nitride of Ti, and has a coating layer of 0.2-10μm in thickness.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the long lasting alumina system ceramic cutting tool which can cut high degree-of-hardness material, such as an alloy tool steel, in high efficiency.
[0002]
[Description of the Prior Art] Cutting is so difficult that machining is very difficult for two or more 500 kgf(s)/mm high degree-of-hardness material and it can hardly cut with cutting tools, such as usual cemented carbide, especially at 50 or more and Vickers hardness (HV) by high degree-of-hardness material, especially ROKKUERU C degrees of hardness (HRC), such as an alloy tool steel.
[0003] Conventionally, the cutting tool which consists of a cubic boron nitride (CBN) sintered compact, or the cutting tool which consists of an alumina (aluminum 2O3) system sintered compact which makes the start the aluminum2O3-TiC system ceramic sintered compact called black Serra was used for cutting of this high degree-of-hardness material.
[0004] However, since the sintered CBN cutting tool needed the extra-high voltage super-elevated temperature for the manufacture process, compared with the cemented carbide cutting tool, its price is very expensive and the configuration of the tool which can be manufactured also had a fault, like a large limit is added. One with it difficult [ to perform stable cutting, such as shortage of toughness being conspicuous, when high degree-of-hardness material is actually cut, although the black Serra cutting tool is cheap and there is remarkable flexibility also in a tool configuration, and being easy to generate a chipping and a flaking, ] on the other hand was actual.
[0005] Thus, although it is thought of because a radial force becomes very large among 3 component of a force of a cutting force that cutting of high degree-of-hardness material becomes difficult, therefore it is cheap, about alumina system ceramic sintered-compact cutting tools, such as black Serra worried to deficit-proof nature who has, to carry out improvement in an improvement of the intensity and toughness is needed.
[0006] Then, the method of making small conventionally particle size of an aluminum2O3 crystal-grain child and a TiC particle by HIP processing about aluminum2O3 system ceramic sintered compacts, such as an aluminum2O3-TiC system, (JP,1-22223,B), Or Nb, V, Zr, Ta, Hf, etc. are added in the form of a metal or an oxide, and the method (JP,63-35587,B) of distributing TiC uniformly minutely and raising sintered-compact intensity is proposed. these methods -- sintering -- cutting of the high degree-of-hardness material to which a radial force becomes large especially although it became possible to lose the pore which exists in the inside of the body, and to raise intensity and a degree of hardness -- setting -- in addition -- the intensity and abrasion resistance -- enough -- **** -- it was not able to say
[0007] The method of aiming at reduction of a cutting force is also taken by wrapping the rake face of a cutting tool and making discharge of a chip easy in addition to the above-mentioned method. Moreover, naturally the method of carrying out forming a breaker etc. and reducing a cutting force is considered, and in a ceramic cutting tool, there is misgiving in an on-the-strength side, and, for a certain reason, the restrictions on manufacture have not spread, either.
[0008]
[Problem(s) to be Solved by the Invention] this invention essentially consists of an alumina system ceramic sintered compact of low prices, such as an aluminum2O3-TiC system, in view of this conventional situation, and it aims at offering the ceramic cutting tool which is high efficiency, and is long lasting and can cut two or more 500 Kgf(s)/mm high degree-of-hardness material by 50 or more and HV especially by HRC.
[0009]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, it sets to the ceramic cutting tool of this invention. in the matrix of;aluminum 2O3 The carbide of 10 - 50% of the weight of Ti, The base material of the alumina system ceramic sintered compact containing at least one sort of a nitride, a charcoal nitride, or a charcoal nitric oxide, (1) [ whether it has the enveloping layer of 0.2-10 micrometers of sum total thickness which consists of at least one sort of the carbide of the alloy of Ti and aluminum prepared in the front face of this base material, a nitride, or a charcoal nitride, and ] (2) -- it is characterized by having the enveloping layer of 0.2-10 micrometers of sum total thickness which consists of at least one sort of the carbide of the alloy of Ti and aluminum prepared in the front face of this base material, a nitride, or a charcoal nitride, and at least one sort of the carbide of Ti, a nitride, or a charcoal nitride of combination [ or ]
[0010] In addition, the chemical formula which carries out the following to the carbide, nitride, or charcoal nitride of an alloy of

Ti and aluminum in this invention. [Formula 1]
(Ti1-xAlx) (C1-yNy) (the inside of a formula, 0< x<1, and 0<=y<=1)
It comes out and the compound expressed is meant.
[0011]
[Function] In this invention, with the combination of the above-mentioned specific base material and an enveloping layer, the surface residual compression stress by the coefficient-of-thermal-expansion difference arises in an enveloping layer, and the toughness of the aluminum2O3 system ceramic sintered compact this [ whose ] is a base material is raised.
[0012] Especially the enveloping layer that consists of the carbide, nitride, or charcoal nitride of an alloy of Ti and aluminum is effective in raising the abrasion resistance of a cutting tool in addition to the effect of the improvement in toughness of the above-mentioned. Although the reason is not clear, aluminum contained in an enveloping layer causes a chemical reaction in part with the elevated temperature produced at the time of cutting, generates aluminum 2O3, and is considered that abrasion resistance is raised by this aluminum 2O3.
[0013] Therefore, as a cutting tool of high degree-of-hardness material, the ceramic cutting tool of this invention is excellent in toughness and abrasion resistance with especially HRC at 50 or more and HV as two or more 500 kgf(s)/mm cutting tools for high degree-of-hardness material, has a several times as many life as this compared with the ceramic cutting tool which consists of an aluminum2O3-TiC system ceramic sintered compact which does not have the conventional enveloping layer, and can perform cutting stabilized in high efficiency.
[0014] Moreover, the carbide, nitride, or charcoal nitride of Ti used combining the carbide of the alloy of Ti and aluminum, a nitride, or a charcoal nitride as an enveloping layer was excellent in the adhesion force with a base material, and it turns out that TiN is excellent in the adhesion force with a base material especially. Therefore, the enveloping layer excellent in especially the adhesion force with a base material can be obtained by setting to TiN the innermost layer which contacts a base material among enveloping layers.
[0015] Furthermore, the carbide, nitride, or charcoal nitride of Ti is cut by including this in an enveloping layer, since coefficient of friction is smaller than the conventional aluminum2O3-TiC system ceramic sintered compact in which grinding was carried out by the carbide, the nitride, the charcoal nitride, and common practice of an alloy of Ti and aluminum, discharge of powder becomes good, and a cutting force is reduced. The effect that TiN makes the cutting force at the time of TiN, then high degree-of-hardness material cutting mitigate the outermost layer of drum of an enveloping layer among the compounds which can constitute especially an enveloping layer since coefficient of friction is the smallest is large.
[0016] In the ceramic cutting tool of this invention, it turns out that it is effective in reduction of a cutting force to make surface roughness [ near the cutting edge ] into less than / 0.2S / at least, a cutting force becomes still smaller, and continues by this at a long period of time, and an usable cutting tool is obtained. Methods, such as surface polish using the diamond paste by the diamond abrasive grain, can be used for improvement in surface roughness.
[0017] The alumina system ceramic sintered compact used as a base material contains at least one compound chosen from the carbide, the nitride, charcoal nitride, or charcoal nitric oxide of Ti into the matrix of aluminum 2O3. Intensity and a degree of hardness are high, and these aluminum2O3 system ceramic sintered compacts are used as a cutting tool of high degree-of-hardness material from the former. However, since a degree of sintering will become bad if the addition of Ti carbide, a nitride, a charcoal nitride, or a charcoal nitric oxide has low intensity and degree of hardness of a sintered compact at less than 10 % of the weight and exceeds 50 % of the weight in order to use as a base material of the cutting tool of this invention, it considers as 10 - 50% of the weight of the range.
[0018] In addition, the above-mentioned alumina system ceramic sintered compact used as a base material is well-known, for example, is obtained by sintering the raw material powder constituent mixed in predetermined proportion at the temperature of about 1500-1900 degrees C. Although hot pressing is desirable as a sintering process, a sintering process and the HIP method are also usually employable. Moreover, naturally on the occasion of sintering, you may use well-known sintering acids, such as NiO, Y2O3, and MgO, as an additive.
[0019] the monolayer which the enveloping layer prepared in the above-mentioned base material front face turns into from the carbide, nitride, or charcoal nitride of an alloy of aluminum and Ti -- or although it consists of a double layer which consists of a double layer or the carbide of these and Ti, a nitride, or a charcoal nitride, even if it is which case, sum total thickness of an enveloping layer is taken as the range of 0.2-10 micrometers The reason is that the toughness of the enveloping layer itself will fall in less than 0.2-micrometer thickness if toughness and the wear-resistant improvement effect are small and exceed 10 micrometers. Moreover, even if little 4A and little 5A, 6A group element, and an iron system metallic element are contained in the carbide, nitride, or charcoal nitride of an alloy of aluminum and Ti of an enveloping layer, there is no change in the excellency of an enveloping layer mentioned above.
[0020] The physical or chemical thin film formation methods, such as well-known PVD and CVD, can be used for formation of the above-mentioned enveloping layer. in addition, the case where the carbide, nitride, or charcoal nitride of an alloy of aluminum and Ti is covered with PVD -- the target of the alloy of Ti and aluminum -- you may use -- Ti and aluminum -- you may install a separate target
[0021]
[Example] After doing 30 volume % mixture of the TiC powder of 1.0 micrometers of mean particle diameters at 2Oaluminum3 powder of 0.4 micrometers of mean particle diameters and filling up a graphite dice with this end of mixed powder, hotpress sintering was carried out at 1650 degrees C into argon gas for 1 hour at the bottom of the pressure of 30MPa(s), and the

aluminum2O3-TiC sintered compact of the cutting chip configuration of a part number SNGN 120408 was manufactured.
[0022] The obtained aluminum2O3-TiC sintered compact was used as the base material, the enveloping layer shown in Table 1 by the usual PVD was formed in the front face, respectively, and the cutting chips 1-12 (however, the cutting chip 12 example of comparison) were produced. Moreover, an enveloping layer was not formed but the cutting chip 13 (example of comparison) which consists only of an aluminum2O3-TiC sintered compact was also prepared.
[0023] Next, the cutting examination was performed on the following conditions using each cutting chips 1-13.
Cutting conditions: ** ** Material -- SKD11 (HRC 60)
Cutting speed -- 100 m/min. ** ** --0.1 mm/rev. Cut [ ** Oil -- Dry type cutting time -- 10min. ] deeply. -- 1.0mm electrode holder -- FN11R44A OFF [0024] The desquamative state of the enveloping layer of each cutting chip was observed, and flank-wear width of face was measured about each cutting chip after an examination, to Table 1, it combined as a cutting test result and the above-mentioned cutting examination was indicated.
[0025]
[Table 1]
OFF ** ** ** Layer Style ** It reaches. Film ** sum total thickness Cutting test-result chip (a inner layer -> outer layer) (micrometer) (micrometer) Flank-wear width of face 1 Ti3AlC (4.0) 4.0 0.08mm 2 TiAlN (4.0) 4.0 0.07mm 3 Ti3AlCN (4.5) 4.5 0.07mm 4 Ti3AlN (4.5) 4.5 0.06mm 5 TiAlN(1.5) ->TiAlCN (2.5) 4.0 0.06mm 6 Ti3AlC(2.0) ->TiAlN (1.5) 3.50.06mm 7 TiN(0.5) ->Ti3AlCN (3.5) 4.0 0.04mm 8 TiN(0.5) ->Ti3AlC(2.0) ->TiAlN (1.5) 4.0 0.04mm9 TiN(1.0) ->TiAlN(3.0) ->TiN (0.5) 4.5 0.04mm 10 TiN(1.0) ->Ti3AlCN(3.0) ->TiN(0.5) * 4.5 0.03mm 11 (Ti-6wt%aluminum-4wt%V) N 4.0 0.09mm 12 TiN (3.0) 3.00.12mm13 With no enveloping layer - Deficit (notes) TiAl is a 50at%Ti-50at%aluminum alloy at 3 minutes. Ti3aluminum means a 75at%Ti-25at% alloy. Moreover, the chip which attached * mark raised surface roughness to 0.2S using diamond paste according to a diamond abrasive grain with a particle size of 30-40 micrometers near the cutting edge.
[0026]
[Effect of the Invention] According to this invention, the ceramic cutting tool of the low price which was excellent in abrasion resistance with high toughness which can cut two or more 500 Kgf(s)/mm high degree-of-hardness material from high efficiency and a high life can be offered by 50 or more and HV by high degree-of-hardness material, such as an alloy tool steel, especially HRC.

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CLAIMS

[Claim(s)]
[Claim 1] The ceramic cutting tool characterized by having the enveloping layer of 0.2-10 micrometers of thickness which consists of at least one sort of the carbide of the base material of the alumina system ceramic sintered compact which contained at least one sort of the carbide of 10 - 50% of the weight of Ti, a nitride, a charcoal nitride, or a charcoal nitric oxide in the matrix of aluminum 2O3, and the alloy of Ti and aluminum prepared in the front face of this base material, a nitride, or a charcoal nitride.
[Claim 2] The ceramic cutting tool characterized by providing the following. The base material of the alumina system ceramic sintered compact which contained at least one sort of the carbide of 10 - 50% of the weight of Ti, a nitride, a charcoal nitride, or a charcoal nitric oxide in the matrix of aluminum 2O3. The enveloping layer of 0.2-10 micrometers of sum total thickness which consists of at least one sort of the carbide of at least one sort and Ti of the carbide of the alloy of Ti and aluminum prepared in the front face of this base material, a nitride, or a charcoal nitride, a nitride, or a charcoal nitride of combination.
[Claim 3] The ceramic cutting tool according to claim 2 characterized by the innermost layer of an enveloping layer being TiN.
[Claim 4] The ceramic cutting tool according to claim 2 or 3 characterized by the outermost layer of drum of an enveloping layer being TiN.
[Claim 5] The ceramic cutting tool according to claim 1 to 4 characterized by surface roughness [ near the cutting edge ] being less than / 0.2S / at least.

[Translation done.]

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(54)【発明の名称】　セラミックス切削工具

(57)【要約】

【目的】　本質的にアルミナ系セラミックス焼結体からなり、高硬度材料を高能率且つ長寿命で切削することの出来るセラミックス切削工具を提供する。

【構成】　$Al_2O_3$のマトリックス中に10～50重量%のTiの炭化物、窒化物、炭窒化物又は炭窒酸化物の少なくとも1種を含有したアルミナ系セラミックス焼結体の母材と、(1)この母材の表面に設けたTiとAlの合金の炭化物、窒化物又は炭窒化物の少なくとも1種からなるか、又は(2)この母材の表面に設けたTiとAlの合金の炭化物、窒化物又は炭窒化物の少なくとも1種と、Tiの炭化物、窒化物又は炭窒化物の少なくとも1種との組み合わせからなり、膜厚が0.2～10μmの被覆層とを備えたセラミックス切削工具。

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【特許請求の範囲】

【請求項１】 $Al_2O_3$のマトリックス中に10～50重量%のTiの炭化物、窒化物、炭窒化物又は炭窒酸化物の少なくとも１種を含有したアルミナ系セラミックス焼結体の母材と、この母材の表面に設けたTiとAlの合金の炭化物、窒化物又は炭窒化物の少なくとも１種からなる膜厚0.2～10μmの被覆層とを備えたことを特徴とするセラミックス切削工具。

【請求項２】 $Al_2O_3$のマトリックス中に10～50重量%のTiの炭化物、窒化物、炭窒化物又は炭窒酸化物の少なくとも１種を含有したアルミナ系セラミックス焼結体の母材と、この母材の表面に設けたTiとAlの合金の炭化物、窒化物又は炭窒化物の少なくとも１種とTiの炭化物、窒化物又は炭窒化物の少なくとも１種との組み合わせからなる合計膜厚0.2～10μmの被覆層とを備えたことを特徴とするセラミックス切削工具。

【請求項３】 被覆層の最内層がTiNであることを特徴とする、請求項２に記載のセラミックス切削工具。

【請求項４】 被覆層の最外層がTiNであることを特徴とする、請求項２又は請求項３に記載のセラミックス切削工具。

【請求項５】 少なくとも切れ刃近傍における表面粗さが0.2S以下であることを特徴とする、請求項１ないし請求項４のいずれかに記載のセラミックス切削工具。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】本発明は、合金工具鋼等の高硬度材料を高能率で切削できる長寿命のアルミナ系セラミックス切削工具に関する。

【０００２】

【従来の技術】合金工具鋼等の高硬度材料、特にロックェルＣ硬度（$H_RC$）で50以上又はビッカース硬度（$H_V$）で500kgf／mm$^2$以上の高硬度材料は、機械加工が極めて難しく、特に通常の超硬合金等の切削工具では殆ど切削できないほど切削加工が困難である。

【０００３】従来、かかる高硬度材料の切削には、立方晶窒化ホウ素（ＣＢＮ）焼結体からなる切削工具、又は黒セラと称される$Al_2O_3$－TiC系セラミックス焼結体を初めとするアルミナ（$Al_2O_3$）系焼結体からなる切削工具が用いられていた。

【０００４】しかし、ＣＢＮ焼結体切削工具は、その製造プロセスに超高圧超高温を必要とすることから、超硬合金切削工具に比べて価格が極めて高価であり、又製造できる工具の形状にも大幅な制限が加わる等の欠点があった。一方、黒セラ切削工具は安価であり工具形状にもかなりの自由度があるものの、実際に高硬度材料を切削すると靭性の不足が目立ち、チッピングやフレーキングが発生しやすい等、安定した切削を行うことが難しいのが現実であった。

【０００５】この様に、高硬度材料の切削が困難になるのは切削抵抗の三分力のうち背分力が非常に大きくなるためと考えられ、従って安価ではあるが耐欠損性に不安のある黒セラ等のアルミナ系セラミックス焼結体切削工具については、その強度及び靭性を改善向上させることが必要とされている。

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【０００６】そこで従来、$Al_2O_3$－TiC系等の$Al_2O_3$系セラミックス焼結体について、ＨＩＰ処理により$Al_2O_3$結晶粒子及びTiC粒子の粒径を小さくする方法（特公平1－22223号公報）、或はNb、V、Zr、Ta、Hf等を金属又は酸化物の形で添加し、TiCを均一微細に分散させて焼結体強度を向上させる方法（特公昭63－35587号公報）が提案されている。これらの方法により、焼結体中に存在するポアを無くして強度及び硬度を向上させることは可能になったが、背分力が特に大きくなる高硬度材料の切削においては尚その強度及び耐摩耗性が十分とは言えなかった。

【０００７】上記方法以外に、切削工具のすくい面をラッピングして切粉の排出を容易にすることにより、切削抵抗の低減を図る方法も取られている。又、ブレーカーを設ける等して切削抵抗を低減する方法も当然考えられるが、セラミックス切削工具では強度面での不安があり且つ製造上の制約もあるため普及していない。

【０００８】

【発明が解決しようとする課題】本発明はかかる従来の事情に鑑み、本質的に$Al_2O_3$－TiC系等の低価格のアルミナ系セラミックス焼結体からなり、特に$H_RC$で50以上又は$H_V$で500Kgf／mm$^2$以上の高硬度材料を高能率で且つ長寿命で切削することの出来るセラミックス切削工具を提供することを目的とする。

【０００９】

【課題を解決するための手段】上記目的を達成するため、本発明のセラミックス切削工具においては；$Al_2O_3$のマトリックス中に10～50重量%のTiの炭化物、窒化物、炭窒化物又は炭窒酸化物の少なくとも１種を含有したアルミナ系セラミックス焼結体の母材と、(1)この母材の表面に設けたTiとAlの合金の炭化物、窒化物又は炭窒化物の少なくとも１種からなる合計膜厚0.2～10μmの被覆層とを備えるか、又は(2)この母材の表面に設けたTiとAlの合金の炭化物、窒化物又は炭窒化物の少なくとも１種と、Tiの炭化物、窒化物又は炭窒化物の少なくとも１種との組み合わせからなる合計膜厚0.2～10μmの被覆層とを備えたことを特徴とする。

【００１０】尚、本発明において、TiとAlの合金の炭化物、窒化物又は炭窒化物とは、下記する化学式

【化１】

$(Ti_{1-x}Al_x)(C_{1-y}N_y)$ （式中、$0<x<1$及び$0\leqq y\leqq 1$）

で表される化合物を意味する。

【００１１】

【作用】本発明では、上記特定の母材と被覆層との組み合わせにより、被覆層に熱膨張係数差による表面残留圧

縮応力が生じ、これが母材である$Al_2O_3$系セラミックス焼結体の靭性を向上させる。

【0012】特に、TiとAlの合金の炭化物、窒化物又は炭窒化物からなる被覆層は、前述の靭性向上の効果に加えて切削工具の耐摩耗性を向上させる効果がある。その理由は明確ではないが、被覆層中に含まれるAlが切削時に生じる高温により一部化学反応を起こして$Al_2O_3$を生成し、この$Al_2O_3$により耐摩耗性が高められるものと考えられる。

【0013】従って、本発明のセラミックス切削工具は高硬度材料の切削工具として、特に$H_RC$で50以上又は$H_V$で500kgf／$mm^2$以上の高硬度材料用の切削工具として、靭性及び耐摩耗性に優れ、従来の被覆層を有しない$Al_2O_3$－TiC系セラミックス焼結体等からなるセラミックス切削工具に比べ数倍の寿命を有し、高能率で安定した切削を行うことが出来る。

【0014】又、被覆層としてTiとAlの合金の炭化物、窒化物又は炭窒化物と組み合わせて使用されるTiの炭化物、窒化物又は炭窒化物は、母材との密着力に優れ、中でもTiNは母材との密着力に優れていることが分かった。従って、被覆層のうち母材と接触する最内層をTiNとすることにより、特に母材との密着力に優れた被覆層を得ることが出来る。

【0015】更に、Tiの炭化物、窒化物又は炭窒化物は、摩擦係数がTiとAlの合金の炭化物、窒化物、炭窒化物や一般的な方法により研削された従来の$Al_2O_3$－TiC系セラミックス焼結体よりも小さいので、これを被覆層に含ませることにより切り粉の排出が良くなり、切削抵抗が低減される。特に被覆層を構成し得る化合物の内でTiNが最も摩擦係数が小さいので、被覆層の最外層をTiNとすれば高硬度材料切削時の切削抵抗を軽減させる効果が大きい。

【0016】本発明のセラミックス切削工具においては、少なくとも切れ刃近傍における表面粗さを0.2S以下とすることが切削抵抗の低減に有効であり、これにより切削抵抗が更に小さくなって、長期に亘り使用可能な切削工具が得られることが分かった。表面粗さの向上には、ダイヤモンド砥粒によるダイヤモンドペーストを用いた表面研磨等の方法を使用できる。

【0017】母材となるアルミナ系セラミックス焼結体は、$Al_2O_3$のマトリックス中にTiの炭化物、窒化物、炭窒化物又は炭窒酸化物から選ばれた少なくとも1つの化合物を含有したものである。これらの$Al_2O_3$系セラミックス焼結体は、強度並びに硬度が高く従来から高硬度材料の切削工具として使用されていたものである。しかし、本発明の切削工具の母材として用いるためには、Ti炭化物、窒化物、炭窒化物又は炭窒酸化物の添加量が10重量％未満では焼結体の強度及び硬度が低く、又50重量％を越えると焼結性が悪くなるので、10～50重量％の範囲とする。

【0018】尚、母材となる上記アルミナ系セラミックス焼結体は公知であり、例えば所定割合に混合した原料粉末組成物を1500～1900℃程度の温度で焼結することにより得られる。焼結法としてはホットプレス法が好ましいが、普通焼結法やＨＩＰ法を採用することも出来る。又、焼結に際しては、添加物としてNiO、$Y_2O_3$、MgO等の公知の焼結助剤を用いて良いことは当然である。

【0019】上記母材表面に設ける被覆層は、AlとTiの合金の炭化物、窒化物又は炭窒化物からなる単層か又は複層、若しくはこれらとTiの炭化物、窒化物又は炭窒化物からなる複層からなるが、いずれの場合であっても被覆層の合計膜厚は0.2～10μmの範囲とする。その理由は、0.2μm未満の膜厚では靭性や耐摩耗性の向上効果が小さく、10μmを越えると被覆層自体の靭性が低下するからである。又、被覆層のAlとTiの合金の炭化物、窒化物又は炭窒化物に、少量の４Ａ、５Ａ、６Ａ族元素や鉄系金属元素が含まれても、前述した被覆層の優秀性に変わりはない。

【0020】上記被覆層の形成には、公知のＰＶＤ法やＣＶＤ法などの物理的又は化学的な薄膜形成方法を利用することが出来る。尚、ＰＶＤ法によりAlとTiの合金の炭化物、窒化物又は炭窒化物を被覆する場合、TiとAlの合金のターゲットを用いても良いし、TiとAl別々のターゲットを設置しても良い。

【0021】

【実施例】平均粒径0.4μmの$Al_2O_3$粉末に平均粒径1.0μmのTiC粉末を30体積％混合し、この混合粉末を黒鉛ダイスに充填した後、アルゴンガス中において30MPaの圧力の下に1650℃で1時間ホットプレス焼結して、型番SNGN120408の切削チップ形状の$Al_2O_3$－TiC焼結体を製造した。

【0022】得られた$Al_2O_3$－TiC焼結体を母材とし、その表面に通常のＰＶＤ法により表１に示す被覆層をそれぞれ形成して、切削チップ１～１２（但し、切削チップ１２は比較例）を作製した。又、被覆層を形成せず、$Al_2O_3$－TiC焼結体のみからなる切削チップ１３（比較例）も準備した。

【0023】次に、各切削チップ１～１３を用いて、下記条件で切削試験を行った。

切削条件：被削材…SKD11（$H_RC$ 60）
切削速度…100m／min.
送　り…0.1mm／rev.
切り込み…1.0mm
ホルダー…FN11R44A
切削油…乾式
切削時間…10min.

【0024】上記切削試験において、各切削チップの被覆層の剥離状態を観察し、又試験後の各切削チップについてフランク摩耗幅を測定し、表１に切削試験結果として併せて記載した。

【0025】

【表1】

| 切削チップ | 被覆層構造及び膜厚（内層→外層）（μm） | 合計膜厚（μm） | 切削試験結果フランク摩耗幅 |
|---|---|---|---|
| 1 | $Ti_3AlC$(4.0) | 4.0 | 0.08mm |
| 2 | TiAlN(4.0) | 4.0 | 0.07mm |
| 3 | $Ti_3AlCN$(4.5) | 4.5 | 0.07mm |
| 4 | $Ti_3AlN$(4.5) | 4.5 | 0.06mm |
| 5 | TiAlN(1.5)→TiAlCN(2.5) | 4.0 | 0.06mm |
| 6 | $Ti_3AlC$(2.0)→TiAlN(1.5) | 3.5 | 0.06mm |
| 7 | TiN(0.5)→$Ti_3AlCN$(3.5) | 4.0 | 0.04mm |
| 8 | TiN(0.5)→$Ti_3AlC$(2.0)→TiAlN(1.5) | 4.0 | 0.04mm |
| 9 | TiN(1.0)→TiAlN(3.0)→TiN(0.5) | 4.5 | 0.04mm |
| 10 | TiN(1.0)→$Ti_3AlCN$(3.0)→TiN(0.5)＊ | 4.5 | 0.03mm |
| 11 | (Ti－6wt%Al－4wt%V)N | 4.0 | 0.09mm |
| 12 | TiN(3.0) | 3.0 | 0.12mm |
| 13 | 被覆層なし | － | 3分で欠損 |

（注）TiAlは50at%Ti－50at%Al合金を、$Ti_3Al$は75at%Ti－25at%合金を意味する。又、＊印を付したチップは切れ刃近傍を粒径30～40μmのダイヤモンド砥粒によるダイヤモンドペーストを用いて表面粗さを0.2Sまで向上させた。

【0026】

【発明の効果】本発明によれば、合金工具鋼などの高硬度材料、特に$H_RC$で50以上又は$H_V$で500Kgf／mm²以上の高硬度材料を、高能率且つ高寿命で切削することができる、高靭性で耐摩耗性に優れた低価格のセラミックス切削工具を提供することが出来る。